

Space Weather Technical Forecast

Issued on Saturday 14 December 2024 at 12:37 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Isolated R1/R2 radio blackouts likely throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with a solitary M1.0 flare observed at 13/1424 UTC from Ex-AR3922. There are four sunspot regions on the Earth-facing disc. The largest of these, AR3920 (Esi/Beta), in the northwest, exhibited decay in its leading portion and spreading of its main, opposing polarity spots. AR3917 (Dkc/Beta-Gamma) in the far southwest, saw weakening of its trailing spots, but also some agglomeration of its leading penumbral spots, with occasional C-class activity observed during the period. AR3924 (Dsi/Beta-Gamma) in the south-centre disc, underwent notable growth, developing a mature leading region, with numerous intermediate and trailing spots of smaller size. Ex-AR3922, in the southeast decayed, as did an unnumbered region in the southwest. Meanwhile, a new, small bipolar region recently emerged in the northeast. This region is as yet unnumbered.

No clear Earth-directed CMEs were observed in available imagery.

Solar Wind / Geomagnetic Activity: Solar winds, as reported by ACE at L1, indicated an ongoing slow wind regime. Solar wind speeds were at background, typically varying between 300-350km/s. Density was largely below average, but increased to average levels from around 14/0800 UTC. The Interplanetary Magnetic Field (IMF), Bt, was largely weak, but became moderate from 14/0900 UTC onwards. The north-south component of the IMF, Bz, IMF varied between +5/-8nT. The phi angle was predominantly positive (away from the Sun). The net result of the above solar wind measures was for Quiet geomagnetic activity throughout.

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 was at Background levels.

High energy electron flux (greater than 2MeV) observed by GOES16 showed a diurnal variation at moderate levels, peaking at 834pfu at 13/1515UTC. The associated 24-hour fluence was below Active, and slowly declining. The 14/0000UTC observation was 2.65e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is likely, with isolated M-class flares. There is a slight chance of isolated X-class flares.

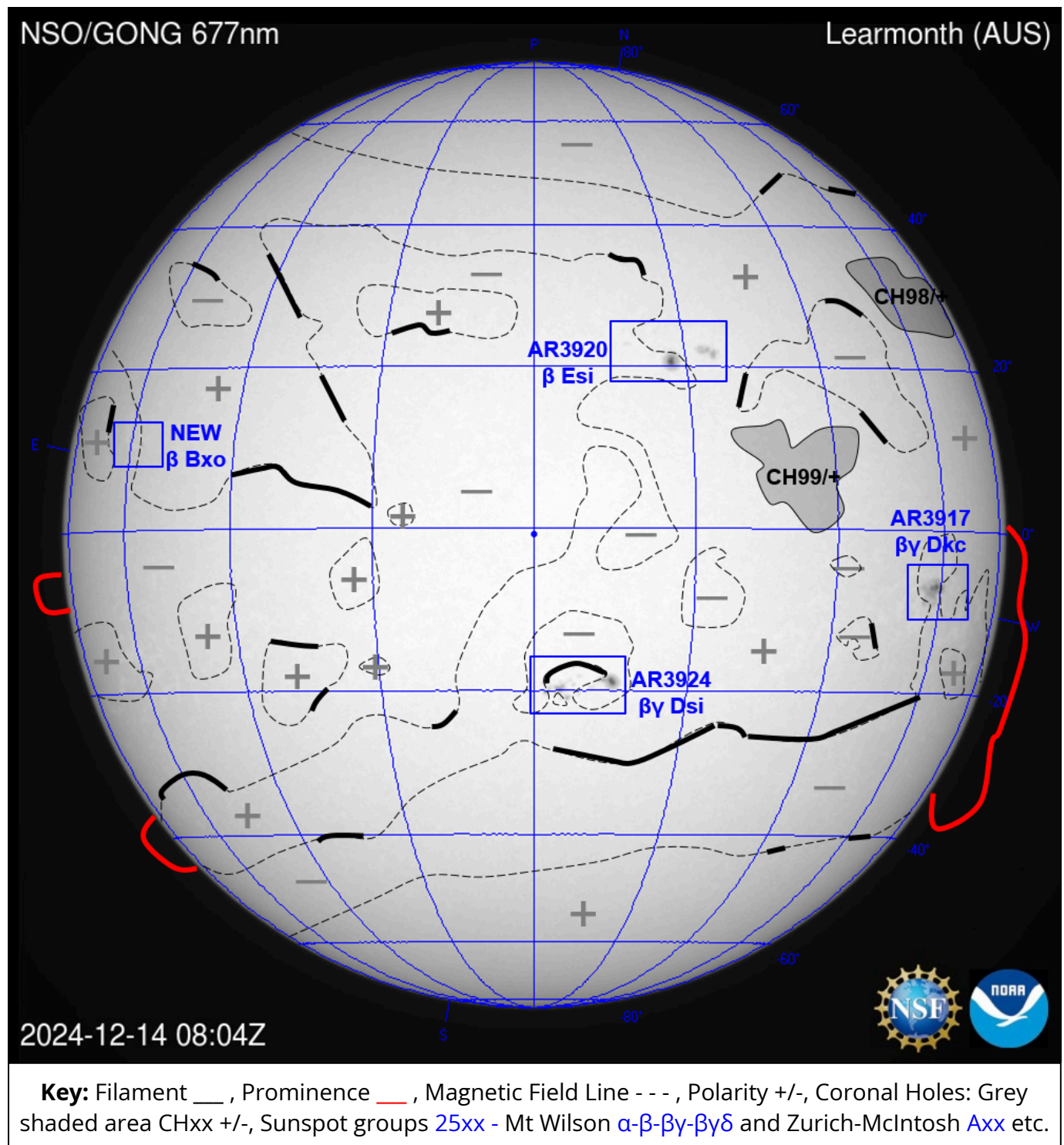
Solar Wind / Geomagnetic Activity: There are no clear Earth-directed CMEs as of the issue of this guidance.

Slow wind conditions are expected until recurrent CH99's onset, most likely late on Day 1 or into Day 2 (14-15 Dec). Geomagnetic activity is expected to start mostly Quiet as a result, then rising to give a spell of Unsettled to Active conditions with a Slight Chance of G1 Minor Storm intervals. Activity and solar winds expected to ease into the new working week, returning conditions to mainly Quiet to Unsettled.

Energetic Particles / Solar Radiation: High energy proton flux is expected to remain at Background, but with a daily slight chance of rising in response to any notable flares.

High energy electron flux is expected to be at occasionally moderate levels, before falling later Day 1 or early Day 2 (14-15 Dec) due to forecast faster solar winds due to CH99. Moderate, perhaps high levels are likely by Day 4 (17 Dec) as solar winds from this feature eases. The 24-hour fluence is expected to remain below the Active threshold.

Figure 1: MOSWOC Solar Synoptic Map valid 14/0800 UTC



Geomagnetic Storms

There are no Earth-directed CMEs expected as of the time of issue, however this carries lower than average confidence due to ongoing imagery gaps and the large numbers of minor events on the disc. A number of significant filaments remain apparent of the visible disc, and these continue to be closely monitored for any potential Earth-directed disruption.

The coronal hole-based forecast is relatively higher confidence. Current background slow wind conditions, and mainly Quiet geomagnetic activity are expected until the onset of the next enhancement from the fast winds of CH99+. This is a persistent feature, and was likely the cause of a weak enhancement that occurred on the previous rotation on 18 Nov. This resulted in peak wind speeds of around 450km/s, and would map to this rotation to give an arrival on Day 2 (15 Dec), perhaps slightly earlier if a stronger fast wind is observed. Despite the slightly elevated winds from CH99's previous rotation, there was little impact on geomagnetic activity. Activity is most likely to be in the Unsettled to Active range, before easing back into the new UTC working week.

MOSWOC ENLIL output is persisting in showing a weak enhancement on Day 1 (14 Dec), which is currently believed to be too quick in connecting to the HSS from CH99, but does increase confidence for a connection to be observed. This is then followed by a more notable enhancement in the model occurring on 16 Dec, which is too late to be from CH99 and has no observable source region currently on this disc. This is consequently considered anomalous and disregarded at this stage.

Geomagnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	5	15	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Radio Blackouts - X-Ray Flares

Solar Activity is currently Moderate with a peak M1.0 flare observed from Ex-AR3922 at 14/1424 UTC. There are four sunspot regions on the Earth-facing disc. The largest of these, AR3920, in the northwest, continues to decay in its leading portion, with spreading of its main, opposing polarity spots. AR3917, another moderately-large group located in the far southwest, has given occasional C-class activity of late, with some agglomeration of its leading penumbral spots, but some decay of its intermediate and trailing spots. AR3924 in the south-centre disc, is the most developmental region at this time, with a mature leading region formed and numerous intermediate and trailing spots of smaller size that appear to be increasing in number. A small bipolar region has recently emerged in the far northeast disc and remains unnumbered at this time.

Regarding the evolution of sunspot regions in the four days, AR3917 will begin to cross the western solar horizon from Day 3 (16 Dec) onwards. There also continues to be the potential for further regions to rotate onto the disc from over the east limb (perhaps corresponding to Ex-AR3911 and Ex-AR3901), with some clear magnetic structure evident on e.g. GOES SUVI 171. Overall, the current flare risks is expected to ebb to nearer the raw risk for the disc over the period, with the recent spate of activity reducing, but we maintain a likelihood of isolated M-class flares with a persistent slight chance of isolated X-class flares pending further developments.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	70	60	60	55
Very Active	R3-R5 (X Class)	No	10	10	10	10

Figure 2: Latest GOES16/18 X-Ray Flux



Solar Radiation Storms (High Energy Protons)

GOES18 proton flux carries a daily slight chance of a response from any significant solar flares. Enhancement most likely from AR3917, which despite showing some signs of simplification and consolidation in extent maintains the risk of a significant flare. The decreasing component of the daily risk from this region late in the period is exceeded by a rising contribution from the other front-sided regions, leading to a very slightly increasing trend through the four days pending further developments.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	10	15	15	15
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = cm ⁻² sr ⁻¹ s ⁻¹)						

High Energy Electrons ($\geq 2\text{MeV}$)

High energy electron flux observed by GOES16 has varied between background and diurnally moderate levels, following from the fast wind enhancement that occurred on 09-10 December. This is expected to continue at occasionally moderate levels on Day 1 (14 Dec), until the onset of any fast wind of CH99/+. This is most likely to occur late on Day 1 or early on Day 2 (14-15 Dec), with a likely dropout in observed flux as a consequence of the increased solar wind pressure. The flux is then expected to recover back to moderate, perhaps high values as the Van Allen belts ease back to encompass GEO into Day 4 (17 Dec).

The associated 24-hour fluence is well below the Active ($1\text{e}8$ integrated flux) threshold, on a declining trend. This is expected to continue through much of the period, before rising again on Day 4 (17 Dec), but expected to remain well below the Active threshold. This trend is supported by REFM, although this is underestimating current fluence values slightly.

GEO Electron Environment	Level ($\text{cm}^{-2}\text{sr}^{-1}\text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2\text{ MeV}$ $\geq 1\times 10^8$	No	1	1	1	5
Very Active	$\geq 2\text{ MeV}$ $\geq 1\times 10^9$	No	1	1	1	1

Figure 3: Latest MOSWOC REFM output and Recurrence. Considered to be good guidance at present.

